ON THE VARIATION OF THE HOURLY METEORO-LOGICAL NORMALS AT KIMBERLEY DURING THE PASSAGE OF A BAROMETRIC DEPRESSION.

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(With 2 Charts.)

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The present paper is the result of an attempt (1) to determine the variation of the hourly normals of the more important meteorological elements introduced by the passage of a barometric depression over Kimberley ; and (2), incidentally, to learn something of the conditions prevailing in the depression itself.

In the absence of synoptic charts, any information under the second head can, of course, only be small in quantity. And I have no means of making it more definite because, for some reason, the Meteorological Commission has steadily, and at all times, refused to allow me to inspect any of their numerous records for this or any other purpose.

The information obtained under the first head is to be regarded as preliminary to a more extended treatment later on, and as indicating the direction of future research.

The ordinary depression may last for any time from a day to a week, and the winds generated may blow with any velocity from 5 to 35 miles an hour—and perhaps up to 50 miles an hour in occasional gusts. When they first become noticeable to all by reason of the strength of the wind, they set in with warm, discomforting gusts from the north or north-west, and pass away with cool, steady winds from south-west or south. They often bring light showers, but not often heavy rain. Frequently the approach of the centre, or trough, is heralded by clouds of dust ; but it is remarkable that equally strong winds in the rear of the centre seldom raise any dust to speak of.

For the purposes of the present discussion, 105 separate depres-

sions have been selected from the records of the six years 1898–1903, namely,

J.	F.	M.	A.	M.	J.	J.	A.	S.	O.	N.	D.
6,	6,	5,	7,	11,	11,	7,	13,	10,	10,	10,	9,

and the hourly elements considered of the day upon which the centre, or trough, of the depression passed over, together with those of the day before and the day after.* Depressions in which the centres belong as much to one day as to another (*i.e.*, when of any four days containing the centre the pressure on the second day is about equal to that on the third, and the pressure on the first about equal to that on the fourth), have not been taken into account. They are equally important with the others, and will be considered at some future opportunity. In selecting our 105 depressions no attempt has been made to distinguish between one type and another, whether they be primary or secondary cyclones, " **V**s," or cols. Such a distinction, which belongs more especially to the province of synoptic meteorology, must also be left over for the present.

It is evident from Table 1 that the average pressure on the first days comes out, as it happens, almost exactly equal to the average pressure on the third days. This is so far fortunate that it gives us three quite central days in an average typical depression to study. It appears, further, from the Table, that the average pressures on the day before and the day after are about equal to the normal means throughout the summer half of the year, but that the normals are considerably the greater during the winter half.† The inference seems to be that, on the whole, during the summer a depression takes about three days to pass over, but that during the winter the depressions are larger and take longer to pass over. For in the winter months the front of a depression is evidently well defined upon the day before the passage of the centre.

In Table 2 the mean hourly values of pressure during the passage of a depression are given, and also the deviations from the normals hour by hour. It is remarkable that the depression does not in the least obliterate the ordinary diurnal variation. The absolutely lowest pressure comes about 4 p.m., and deviates at the same time by the greatest amount from the normal. Since the

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* These may be conveniently distinguished as the first, the second, and the third days.

† The monthly normal means of the various elements used in the text are taken from " An Elementary Synopsis, &c.," in *Trans*. S. A. Phil. Soc., vol. xiv., part 2. The hourly normals are from " The Determination of Mean Results, &c.," in *Report* of the S. A. A. A. S., vol. i. The first are obtained from four years' observations, the second from five. In consequence the means of the monthly and hourly averages differ a little.

normal minimum also comes at the same time, it follows that the depression here simply exaggerates the normal conditions of pressure. The downward tendency of the barometer during the mornings of the day before and of the day itself causes the principal maximum of pressure to come fully half an hour earlier, namely, from 9 a.m. to 8.30 a.m., and in the same way retards it to 9.30 a.m. on account of the upward tendency during the day after. Also the secondary maximum, occurring normally at 11 p.m., comes an hour earlier on the first day, and perhaps an hour later both on the day and the day after. In the same way the afternoon minimum of pressure comes later on the first day and earlier on the third. The greatest variation is shown by the morning minimum of pressure. It comes half an hour later on the first day, nearly an hour later on the second, and becomes practically abortive on the third, showing itself, indeed, more as a retarded rise than an actual fall. The deviations of pressure increase from appreciably zero to about one-seventh of an inch in 40 hours, decreasing to zero again in the remaining 32 hours. The double amplitude in the average depression lasting three days is ·21 inch—that is, ·12 inch greater than the double amplitude of the ordinary diurnal oscillation; the double amplitude on the day in which the centre passes over is actually only ·02 inch greater than the normal.

The mean temperature of the first day is between one and two degrees higher than the normal; on the second day it is on the whole about half a degree higher still; while on the third day it is between three and four degrees lower than the normal. According to the hourly means of Table 4 the first day opens with a temperature slightly higher than the normal; there is then a gradual positively-increasing deviation throughout the day until sunset; for a few hours during the evening the temperature is falling rather more rapidly than is usually the case; but by sunrise of the second day the positive deviation is as large as before. There are signs of three maxima in the positive deviation of temperature on the second day, *i.e.*, just after sunrise, at noon, and just after sunset. How far they arise simply from the shortness of the record it is hard to say. Certainly the drop at 3 p.m. on the first day can scarcely be other than fortuitous.* After sunset of the second day the fall of temperature is rapid, a zero deviation being reached at midnight. From midnight onwards the negative deviation increases until it reaches nearly −6° at noon. During the succeeding afternoon this slackens

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* A reference to Table 8 will discover a pronounced maximum in the frequency of rain at this time. A more extended record would probably to some extent smooth out this asperity as well as that of temperature.

somewhat to $-3°\cdot5$ at 7 p.m., after which it increases again. Thus, on the whole, the effect of a depression is to exaggerate the diurnal curve of temperature somewhat on the first day, rather less on the second day, and to depress it on the third; that is to say, in the front of the depression the range of temperature is increased, in the rear the range is decreased, while along the trough it is not greatly affected. When we come to consider the variation in the aspect of the sky we shall find, perhaps, a reasonable explanation of the more rapid fall of temperature after sunset on the third day in the decreasing cloudiness and vapour-tension, and consequently increasing radiation. But the rapid fall after sunset on the first day is certainly not so easily explained. It has undoubtedly some connection with the variation in the velocity of the wind, to be presently referred to; but the nascent clouds proper to this part of the front of the depression, so far from acting as a blanket and checking the escape of heat from the lower air, would seem the rather to be actually themselves radiating cold to the earth.

The behaviour of the dew-point is not in the least like that of the temperature or pressure. Only from sunset of the first day to noon of the second is the deviation in the quantity of water vapour from the normal positive. The actual maximum positive deviation is at sunrise on the second day. Throughout the preceding 30 hours the quantity of vapour gradually increases relatively to the normal diurnal curve, hour by hour; in the following 42 hours the quantity as regularly decreases, saving one or two minor fluctuations not of any great consequence. The semi-diurnal oscillation of vapour-tension, of which the maxima come at about 10 a.m. and just before sunset, is on the whole more disturbed than is the case with the curves of the other elements. The times of the phases of the curve of vapour-tension in the depression will be best understood by reference to Table 6. The sunset maximum on the second day seems almost entirely smothered. We learn also from the Table that there is no great accession of water-vapour at any time during the passage of a depression, the greatest positive deviation from the normal tension not at any hour materially exceeding $\cdot015$ inches. In fact it is characteristic of a Kimberley cyclonic disturbance that such variation as there is in the quantity of water vapour obtrudes itself more in the dryness following the trough than in the prior dampness.

The deviation from the normal amount of cloud, though somewhat irregular, as might be expected, is similar to that of the quantity of water vapour. Starting from about the ordinary average at the opening of the first day, the deviation is altogether positive during

the second day, and altogether negative during the third. Table 7 gives the respective annual means for the six hours of observation. The separate monthly means are not definite enough to be worth printing in full. By dividing the cloud types into cirriform, cumulus, and stratiform we get the following cyclonic variation in the mean monthly number of times observed :—

	Day Before.	Day.	Day After.
High-level clouds	8·0	8·4	6·6
Middle-level clouds	11·5	16·7	9·5
Low-level clouds	4·3	5·8	2·2

It appears from this that clouds of a cirrus type are not very much affected in quantity by the depression, and that the chief influence is upon the cumulus and other comparatively low-level clouds. It is worth notice that the variation in the frequency of rain is almost the same as that of the lower clouds. This rain frequency is such that in every 100 depressions rain is observed in 30 on the first day, in 44 on the second, and in 27 on the third; that is, on the day upon which the trough is passing over the chance of rain is half as great again as it is on the first day. During the three days we are considering the total rainfall is slightly less than three times the daily average of the year. The average daily amount is ·051 inch, while the average daily amount in the depression is ·046 inch, or 90 per cent. To make this, 94 per cent. of the daily average falls on the first day, 149 per cent. on the second, and only 27 per cent. on the third. It seems from this that the rain of the third day, when it does come, is only of about one-quarter the intensity of that of the first and second days.

It seems to be a fair inference from a comparison between the temperatures, dew-points, clouds, and rain of the day before, and the same elements of the day after the passage of a depression, together with the dust on the first and second days and its absence on the third, that the air currents have an upward tendency in front of the centre and a downward tendency in the rear.

Table 8 gives the number of times rain has been observed at any hour in the 315 special days under review, *i.e.*, in 105 depressions. We see from this that the relative hourly frequency of each day is very similar to that of the relative daily frequency. Also that in spite of the falling-off on the third day the diurnal curve of hourly frequency is not materially affected.

Table 9 gives the variation in the velocity of the wind in miles per day, month by month. The greatest daily velocity is attained in the spring, October being the month of maximum velocity, and

also the month showing the greatest increase of velocity from the first day to the second. But because the daily velocity of the wind is greatest in the spring months it does not always follow that the wind attains its greatest force at the same time. Stronger winds are, in fact, occasionally experienced in July than in February. Moreover, the average velocity between 2 p.m. and 3 p.m. in July, on the second day, is 13½ miles per hour; the highest average velocity in February is less than 12¼ miles per hour, between 5 p.m. and 6 p.m., on the second day. The greater daily velocity attained in the spring and summer months is simply due to the fact that during the winter the wind, however hard it may blow during the day, generally falls at sunset, whereas in the warmer months the high speed is maintained far into the night.

The diurnal variation in the velocity of the wind is as evident during the passage of a depression as it is at other times, although the shape of the curve is considerably modified. In general the average velocity changes from 5·0 miles an hour just after midnight to 4·4 miles an hour just before sunrise, and to 7·8 miles just after noon. During a depression the maximum comes rather later on all three days, the corresponding velocities changing according to Table 10 :—

	Midnight.		Before Sunrise.		After Noon.
First day, from	4·4	to	4·2	to	9·0
Second day, from	4·4	to	4·4	to	13·1
Third day, from	6·3	to	5·7	to	8·0

We distinguish, then, in this way between general and cyclonic winds at Kimberley, so far as the class we are considering is concerned—that in front of the trough the range of velocity is greater, being lighter by night and stronger by day, while in the rear the range is smaller. In fact, the velocity at the midnight following the passage of the trough is half as great again as that twenty-four hours earlier. Some of the variations in question may be due in part to the fact that the winds observed are, to some extent, resultants compounded of normal winds and winds proper to the cyclone. Thus the normal wind between sunrise and noon is from some northerly direction; also the *cyclonic* wind in front of the cyclonic depression is likely, of itself, to be from some similar azimuth. We should expect here, therefore, an accelerated velocity. But the cyclonic wind in the rear of the depression is likely, of itself, to be from some southerly direction, and we should, therefore, expect a retarded velocity. Again the normal wind after sunset is from south-west to south, and this is also the likely

direction of a cyclonic wind in the rear of a depression. Thus we get accelerated velocities after sunset of the second day, and, by the same token, retarded velocities after sunset of the first day. But such a line of suggestion leave unexplained, and in fact contradicts, the low velocities before sunrise of the second day and the high velocities before sunrise of the third. The rapid slackening of velocity after sunset of the first day relatively to the normal curve deserves attention if only because of the rapid cooling of the air at the same time.

Table 11 gives the total number of hours of wind from each of 16 directions in the 105 depressions (*i.e.*, 315 days) we are considering. There seem to be two prevailing directions on both the first and second days. On the first day directions in the first and second quadrants prevail; on the second day in the second and third quadrants. On the third day there is a single prevailing direction in the third quadrant; so much so that the wind is more peristent from the south-south-west than from all points having a northerly component, including east and west, put together. The actual diurnal variation of each direction is not materially affected at any time, *e.g.*, the third quadrant winds have their maximum frequency near the same hour of the afternoon on all three days as under ordinary circumstances.

The hourly components of wind-frequency are set out in Table 12. The north component commences the three days slightly negative (*i.e.*, it is slightly southerly), but changes to positive about 1 a.m., and remains so until the trough has passed, after which it is negative for the remainder of the period. It has positive maxima at 10 a.m. on the first day, and at 9 a.m. on the second, while the negative maxima fall at 7 p.m. on the first day, 6.30 a.m. and 7 p.m. on the third. The east component has positive maxima about an hour before sunrise, and negative maxima about 2.30 p.m. on each day. Thus the phases of the east component are practically unaltered by the depression, such changes as the Table reveals falling almost entirely upon the north component. This very important fact should be compared with a certain previous result that the east component curve at Kimberley is essentially a curve of temperature.

The angle ϕ in Table 12 represents the angle described by the resultant wind direction from the east round by north, west, south. This angle is greater than the normal between midnight and 10 a.m. on the first day, and between midnight and 3 p.m. on the second day, but it reaches its starting position on the second day not by boxing the compass but by backing after 4 p.m. on the first day. Throughout the whole of the second day the resultant veers

continuously, and continues so to do until sunrise of the third day. It then backs by pretty well a right angle until 2 p.m., after which it approximates to a normal position.

The intensity and angular velocity of the resultant are displayed graphically in Fig. 1. In this diagram O is the origin of co-ordinates; and the resultant wind at any time is supposed to move from a given point on the curve towards O. Thus the line joining XX to O will represent the position and magnitude of the resultant wind direction (exclusive of velocity) between 7 p.m. and 8 p.m. It is pretty clear that the backing indicated by Table 12 between 4 p.m. and midnight of the first day, and between 6 a.m. and 3 p.m. of the third day, is only apparent, and that the extremity of the resultant steadily veers hour after hour. There are one or two minor irregularities which would most likely be smoothed out in a longer series. The whole portion of the curve, however, of the day before lies in a loop outside the origin to the north, and that of the day after is also wholly outside to the south-south-west. In the normal curve of Kimberley wind the veering, both in tabular and diagrammatic form, is complete, the origin being inside the curve. The orientations of the major axis of the normal curve, and of those in our diagram, are pretty nearly the same. Hence it seems that one of the most important variations introduced by the passage of a depression is to transfer the normal resultant-direction wind curve bodily to the north of the origin as the depression approaches, and to the south as the depression recedes. The vane tends strongly to the north-west of the normal direction during the morning of the day before, and still further westerly during the morning of the day of lowest pressure; it also tends strongly south-west of its normal position during the afternoon of the day after. At 8.30 a.m., *e.g.*, the normal resultant direction makes an angle of 62 degrees with the east and west line, whereas 31 hours before the passage of the centre it is 69 degrees, and seven hours before it is 100 degrees. An effect of this is that pronounced easterly directions are eliminated in cyclonic weather, although they are not, as it happens, replaced by very decided westerly directions.

In 1894–5 I made some comparisons between the barometric pressures of Kimberley, Durban, and Cape Town (as published casually in the *Cape Times*). It seemed from this that, on the whole, low pressures were experienced during the same day at Durban and Kimberley,[*] but from 20 to 40 hours earlier at Cape

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[*] The annual depression of the middle of July is experienced, on the whole, a day earlier at Durban than at Kimberley. See " Some Pressure and Temperature Results," &c., in *Trans.* S. A. Phil. Soc., vol. xi., pt. 4.

Town. I was unable to advance the investigation far for lack of material. In 1901, however, Professor J. T. Morrison, working on a better basis, quite independently, said that he had, with the help of Mr. C. Stewart, made a comparison of the daily pressures at Cape Town with those of Durban and Kimberley, and found that while the several places showed the same changes, Cape Town was almost invariably a day earlier than Durban. * Fig. 2 gives a specimen of the sort of evidence upon which my own opinion was founded. It is a diagram drawn by me in May, 1894, to depict the relation between the simultaneous changes of pressure at Kenilworth (Kimberley) and Cape Town. Durban pressures were added a few months later from some observations kindly sent me by Mr. Nevill; and within the last few weeks I have been able to add those for East London from observations kindly lent to me by the Harbour Board. The comparative charts for other months of 1894 and 1895 are equally conclusive, but May, 1894, is given in particular because in that month the *Cape Times* happened to print the daily observations without a break. The Kimberley pressures are plotted from observations made three times a day, at 8 a.m., 2 p.m., and 8 p.m.; Cape Town from two, at 8 a.m. and noon; Durban one, at 9 a.m. (Natal time); East London one, at 8 a.m. The diagram leaves very little doubt that crests and depressions appear at Durban and Kimberley on the same day, at East London slightly earlier on the average, and at Cape Town earlier still. This fact disposes of the idea (if such a random guess wanted disposing of) that depressions travel from west to east across South Africa. It also proves that they do not come from the Indian Ocean, nor from the north. Plainly they come inland from some southerly direction, by preference south-westerly. I have tried to carry an imaginary cyclone across a map of South Africa, which should account for Fig. 2, and in which the cyclonic winds, combined with the normal winds of Kimberley, should give the resultant winds of Fig. 1. A cyclonic path from about south-west to north-east accounts most satisfactorily for both diagrams.† Further research may improve the method and lay down the actual mean path of the centres of the depressions, and

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* See "Some Pressure and Temperature Results," &c., in *Trans.* S. A. Phil. Soc., vol. xi., pt. 4, p. li.

† To a certain extent bearing upon this is a remark of Sparrman:—"The people at this place [Zwellendam] pretend to have observed that the wind, when it blew from the south-east at the Cape, was always northerly with them; and that, when it had ceased raining at the Cape, they had still slight showers at Zwellendam." (Sparrman, "A Voyage to the Cape of Good Hope," second edition, 1786, vol. i., p. 223). The assertion has probably some foundation in fact.

also may distinguish between the paths of the different varieties of depression, but it will certainly not greatly modify the mean direction here claimed.

TABLE 1.

MONTHLY MEANS OF BAROMETRIC PRESSURE DURING THE PASSAGE
OF A DEPRESSION.

	Day Before.	Day.	Day After.	Normal Means.
	Inches.	Inches.	Inches.	Inches.
January	26·011	25·961	26·020	26·008
February	26·045	25·963	26·015	26·067
March	26·069	25·991	26·082	26·089
April	26·124	26·058	26·105	26·177
May	26·205	26·087	26·146	26·223
June	26·238	26·149	26·190	26·299
July	26·147	26·087	26·207	26·249
August	26·111	26·037	26·151	26·231
September...............	26·143	26·061	26·198	26·171
October	26·090	25·956	26·058	26·086
November	26·040	25·961	26·029	26·039
December	26·013	25·937	26·010	26·025
Year	26·103	26·020	26·101	26·139

TABLE 2.

Hourly Means of Barometric Pressure during the Passage of a Depression.

Hour.	Averages.			Deviation from the Normal.		
	Day Before.	Day.	Day After.	Day Before.	Day.	Day After.
	Inches.	Inches.	Inches.	Inch.	Inch.	Inch.
M	26·147	26·060	26·052	+ ·004	− ·083	− ·093
I................	26·142	26·051	26·052	+ ·003	− ·088	− ·087
II.	26·135	26·042	26·052	·000	− ·093	− ·083
III.	26·130	26·035	26·055	− ·002	− ·097	− ·077
IV.	26·129	26·032	26·063	− ·005	− ·102	− ·071
V.	26·133	26·036	26·075	− ·008	− ·105	− ·066
VI.	26·143	26·044	26·093	− ·010	− ·109	− ·060
VII.............	26·151	26·051	26·110	− ·014	− ·114	− ·055
VIII.	26·159	26·058	26·128	− ·016	− ·117	− ·047
IX.	26·159	26·057	26·135	− ·020	− ·122	− ·044
X.	26·152	26·051	26·137	− ·024	− ·125	− ·039
XI.	26·139	26·036	26·131	− ·026	− ·129	− ·034
Noon	26·114	26·011	26·119	− ·031	− ·134	− ·026
XIII.	26·087	25·986	26·104	− ·037	− ·138	− ·020
XIV.	26·064	25·965	26·091	− ·041	− ·140	− ·014
XV.............	26·050	25·954	26·084	− ·044	− ·140	− ·010
XVI.	26·041	25·948	26·082	− ·048	− ·141	− ·007
XVII..........	26·037	25·956	26·085	− ·054	− ·135	− ·006
XVIII.	26·043	25·972	26·097	− ·057	− ·128	− ·003
XIX.	26·050	25·992	26·112	− ·063	− ·121	− ·001
XX.............	26·062	25·014	26·128	− ·065	− ·113	+ ·001
XXI.	26·065	25·030	26·140	− ·072	− ·107	+ ·003
XXII..........	26·068	25·044	26·147	− ·075	− ·099	+ ·004
XXIII.	26·065	25·049	26·150	− ·079	− ·095	+ ·006
	26·103	26·020	26·101	− ·033	− ·116	− ·035

TABLE 3.

Monthly Means of Air Temperature during the Passage of a Depression.

	Day Before.	Day.	Day After.	Normal Means.
	°	°	°	°
January	75·3	76·2	73·6	74·2
February ...	76·3	76·2	71·9	74·4
March	68·6	68·8	66·2	69·5
April	64·2	64·2	59·0	63·0
May	54·5	55·7	49·8	54·1
June	51·3	51·8	47·5	49·6
July	51·6	50·5	43·6	48·4
August	57·5	57·3	48·1	54·6
September...	62·8	64·6	54·3	62·1
October	68·4	69·0	62·3	65·3
November ...	72·2	74·2	68·1	71·0
December ...	76·2	76·8	71·2	74·4
Year	64·9	65·4	59·6	63·4

TABLE 4.

Hourly Means of Air Temperature during the Passage of a Depression.

Hour.	Averages.			Deviation from the Normal.		
	Day Before.	Day.	Day After.	Day Before.	Day.	Day After.
	°	°	°	°	°	°
M....	56·8	58·3	56·3	+ 0·5	+ 2·0	0·0
I.	55·8	57·1	54·5	+ 0·6	+ 1·9	− 0·7
II..........	54·6	56·1	53·1	+ 0·6	+ 2·1	− 0·9
III.	53·7	55·5	52·0	+ 0·5	+ 2·3	− 1·2
IV.	52·9	54·9	50·9	+ 0·5	+ 2·5	− 1·5
V.	52·2	54·2	49·5	+ 0·7	+ 2·7	− 2·0
VI.	52·3	54·3	49·0	+ 0·7	+ 2·7	− 2·6
VII.	55·1	56·5	50·7	+ 1·4	+ 2·8	− 3·0
VIII. ...	61·1	62·1	55·3	+ 2·0	+ 3·0	− 3·8
IX.	66·8	67·3	59·7	+ 2·0	+ 2·5	− 4·9
X..........	71·3	71·3	63·2	+ 2·4	+ 2·4	− 5·7
XI.	74·6	75·1	66·4	+ 2·4	+ 2·8	− 5·9
Noon ...	77·1	77·4	68·7	+ 2·5	+ 2·8	− 5·9
XIII. ...	78·7	78·8	70·6	+ 2·4	+ 2·5	− 5·7
XIV. ...	79·4	79·2	71·5	+ 2·5	+ 2·3	− 5·4
XV.	78·6	78·8	71·7	+ 1·8	+ 2·0	− 5·1
XVI. ...	78·3	76·9	71·0	+ 2·6	+ 2·2	− 4·7
XVII. ...	75·1	74·8	68·2	+ 2·6	+ 2·3	− 4·3
XVIII....	70·3	70·6	64·3	+ 2·3	+ 2·6	− 3·7
XIX. ...	66·6	66·9	60·9	+ 2·2	+ 2·5	− 3·5
XX.	64·0	64·4	58·5	+ 1·8	+ 2·2	− 3·7
XXI. ...	61·9	62·0	56·3	+ 1·6	+ 1·7	− 4·0
XXII. ...	60·5	59·7	54·4	+ 1·7	+ 0·9	− 4·4
XXIII....	59·4	58·0	53·1	+ 2·0	+ 0·6	− 4·3
	64·9	65·4	59·6	+ 1·7	+ 2·2	− 3·6

TABLE 5.

MONTHLY MEANS OF DEW-POINT TEMPERATURE DURING THE PASSAGE OF A DEPRESSION.

	Day Before.	Day.	Day After.	Normal Means.
	°	°	°	°
January	51·6	51·2	41·7	52·4
February ...	54·5	53·3	52·2	52·6
March	52·3	52·2	47·2	55·2
April	49·3	49·2	44·7	50·4
May	41·6	41·1	37·2	39·5
June	34·7	35·5	34·6	34·8
July	31·8	32·9	30·8	33·8
August	37·4	36·4	33·8	35·0
September ...	37·2	37·3	34·0	37·9
October	41·4	41·6	37·9	42·2
November ...	40·4	42·2	41·5	44·3
December ...	51·7	48·9	41·7	50·1
Year	43·7	43·5	39·8	44·0

TABLE 6.

Hourly Means of Dew-point Temperature during the Passage of a Depression.

Hour.	Averages.			Deviation from the Normal.		
	Day Before.	Day.	Day After.	Day Before.	Day.	Day After.
	o	o	o	o	o	o
M	42·2	43·3	40·4	−0·5	+0·6	−2·3
I.	42·5	43·6	40·3	−0·3	+0·8	−2·5
II.........	42·2	43·5	39·9	−0·4	+0·9	−2·7
III.	41·7	43·4	39·4	−0·7	+1·0	−3·0
IV.	41·5	43·2	39·0	−0·7	+1·0	−3·2
V.........	41·5	43·4	38·6	−0·8	+1·1	−3·6
VI.	42·2	44·0	39·0	−0·4	+1·4	−3·6
VII.	43·1	44·7	39·8	−0·3	+1·3	−3·6
VIII. ...	44·2	45·4	40·8	−0·3	+0·9	−3·7
IX.	45·1	46·0	41·4	−0·2	+0·7	−3·9
X.........	45·2	45·8	41·4	−0·2	+0·4	−4·0
XI.	45·2	45·6	41·5	−0·1	+0·3	−3·8
Noon ...	44·9	44·9	40·9	−0·1	−0·1	−4·1
XIII. ...	44·5	44·6	40·6	−0·1	0·0	−4·0
XIV. ...	44·3	44·1	40·3	−0·1	−0·3	−4·1
XV.	44·1	43·6	39·7	+0·1	−0·4	−4·3
XVI. ...	43·8	42·8	39·5	0·0	−1·0	−4·3
XVII. ...	44·5	42·7	39·8	0·0	−1·8	−4·7
XVIII....	44·5	42·3	39·5	+0·1	−2·1	−4·9
XIX. ...	44·7	42·0	39·6	+0·5	−2·2	−4·6
XX.	44·4	41·4	38·9	+0·6	−2·4	−4·9
XXI. ...	44·0	40·9	38·4	+0·7	−2·4	−4·9
XXII. ...	43·7	41·0	37·9	+0·6	−2·1	−5·2
XXIII....	43·5	40·8	37·5	+0·6	−2·1	−5·4
	43·7	43·5	39·8	0·0	−0·2	−3·9

TABLE 7.

MEANS OF CLOUD PERCENTAGE DURING THE PASSAGE OF A DEPRESSION.

Hour.	Averages.			Deviation from the Normal.		
	Day Before.	Day.	Day After.	Day Before.	Day.	Day After.
	%	%	%	%	%	%
VIII................	29	41	27	0	+12	− 2
XI..................	25	37	26	− 3	+ 9	− 2
XIV.	40	51	26	+ 3	+14	−11
XVII.	35	40	22	0	+ 5	−13
XX.	33	33	13	+ 6	+ 6	−14
XXIII.	34	27	8	+11	+ 4	−15
	33	38	20	+ 3	+ 8	−10

TABLE 8.

TOTAL HOURLY RAIN FREQUENCY DURING THE PASSAGE OF 105 DEPRESSIONS.

Hour Ending	Day Before.	Day.	Day After.
	Times.	Times.	Times
I.	4	4	4
II.	3	3	3
III.	2	3	3
IV.	1	3	3
V.......................	—	4	4
VI.	2	3	3
VII.....................	—	3	3
VIII.	2	3	—
IX.	2	3	1
X.	1	2	—
XI.	2	4	—
Noon	3	3	—
XIII.	2	6	1
XIV.	3	5	1
XV.......................	8	6	1
XVI.	6	7	2
XVII.	4	11	3
XVIII.	4	9	2
XIX.	5	8	1
XX......................	10	8	3
XXI.	6	7	6
XXII.	7	5	6
XXIII.	3	8	4
Midnight..............	2	6	2
	82	124	56

TABLE 9.

MONTHLY MEANS OF WIND-VELOCITY, IN MILES PER DAY,
DURING THE PASSAGE OF A DEPRESSION.

	Day Before.	Day.	Day After.
	M. per D.	M. per D.	M. per D.
January	179·4	213·5	149·3
February	145·2	209·2	216·0
March	149·1	158·1	131·0
April.................	115·0	182·9	118·2
May	100·1	164·5	166·4
June.................	128·8	166·2	121·0
July	143·7	176·0	120·7
August..............	167·7	222·1	126·7
September	148·5	228·3	173·7
October	166·4	261·2	196·0
November	147·1	219·6	163·2
December	166·7	212·3	166·2
Year..................	146·5	201·2	154·0

TABLE 10.

Hourly Means of Wind-velocity, in Miles per Hour, during the Passage of a Depression.

Hour Ending	Averages.			Deviation from the Normal.		
	Day Before.	Day.	Day After.	Day Before.	Day.	Day After.
	M. per H.	M. per H.	M. per H.	M. per H.	M. per H.	M. per H.
I.	4·4	4·4	6·3	−0·6	−0·6	+1·3
II.	4·4	4·4	6·1	−0·5	−0·5	+1·2
III.	4·3	4·5	5·9	−0·4	−0·2	+1·2
IV.	4·2	4·5	5·9	−0·4	−0·1	+1·3
V................	4·2	4·4	5·8	−0·2	0·0	+1·4
VI.	4·5	4·5	5·7	+0·1	+0·1	+1·3
VII.............	4·8	5·1	6·0	0·0	+0·3	+1·2
VIII.	5·6	6·3	6·5	+0·1	+0·8	+1·0
IX.	6·6	8·4	6·8	+0·1	+1·9	+0·3
X................	7·8	10·1	7·1	+0·6	+2·9	−0·1
XI.	8·5	11·0	7·2	+0·9	+3·4	−0·4
Noon	8·6	12·1	7·4	+0·9	+4·4	−0·3
XIII.	9·0	12·9	7·7	+1·2	+5·1	−0·1
XIV.	8·9	13·1	8·0	+1·2	+5·4	+0·3
XV..............	8·8	13·1	7·8	+1·1	+5·4	+0·1
XVI.	8·5	13·1	7·6	+1·2	+5·8	+0·3
XVII.	7·6	12·6	7·0	+0·9	+5·9	+0·3
XVIII.	6·4	10·8	6·4	+0·6	+5·0	+0·6
XIX.	5·6	9·0	5·5	+0·4	+3·8	+0·3
XX..............	5·1	8·4	5·6	−0·1	+3·2	+0·4
XXI.	4·6	7·9	5·5	−0·7	+2·6	+0·2
XXII..........	4·5	7·5	5·6	−0·7	+2·3	+0·4
XXIII.	4·7	6·7	5·3	−0·5	+1·5	+0·1
Midnight......	4·6	6·5	5·5	−0·6	+1·3	+0·3
	6·2	8·4	6·4	+0·3	+2·5	+0·5

TABLE 11.

NUMBER OF HOURS OF WIND IN 105 DEPRESSIONS (315 DAYS) FROM EACH OF THE SIXTEEN STANDARD DIRECTIONS.

	Day Before.	Day.	Day After.
N.	256	202	40
N.N.E.	197	164	26
N.E.	207	157	45
E.N.E.	346	186	74
E.	173	72	46
E.S.E.	114	59	139
S.E.	97	56	203
S.S.E.	113	59	345
S.	67	110	350
S.S.W.	88	258	502
S.W.	81	234	374
W.S.W.	95	162	179
W.	86	112	57
W.N.W.	112	180	35
N.W.	152	198	43
N.N.W.	330	303	61

TABLE 12.
COMPONENTS OF WIND-FREQUENCY.

Hour Ending	Day Before N.	Day Before E.	Day Before φ.	Day N.	Day E.	Day φ.	Day After N.	Day After E.	Day After φ.
	Hours.	Hours.	° '	Hours.	Hours.	° '	Hours.	Hours.	° '
I.	− 1·648	+ 60·482	358 26	+ 19·313	+ 37·974	26 57	− 49·829	− 19·567	248 34
II.	+ 3·140	+ 56·226	3 12	+ 28·083	+ 36·665	37 27	− 55·921	− 19·753	250 33
III.	+ 6·309	+ 52·776	6 49	+ 28·605	+ 38·942	36 18	− 58·600	− 15·190	255 28
IV.	+ 10·515	+ 55·947	10 39	+ 31·759	+ 40·628	38 1	− 61·050	− 11·180	259 37
V.	+ 14·004	+ 58·324	13 30	+ 35·543	+ 46·359	37 29	− 62·913	+ 6·259	264 19
VI.	+ 17·167	+ 57·203	16 42	+ 35·588	+ 40·478	41 20	− 61·095	+ 1·920	271 48
VII.	+ 24·581	+ 56·256	23 36	+ 44·595	+ 33·933	52 44	− 64·476	− ·541	269 31
VIII.	+ 36·806	+ 45·657	38 53	+ 64·272	+ 15·352	76 34	− 62·999	− ·880	269 12
IX.	+ 59·142	+ 22·846	68 53	+ 67·065	− 12·176	100 17	− 52·699	+ 9·095	260 13
X.	+ 69·674	− 6·331	95 12	+ 66·625	− 32·966	116 19	− 50·214	− 11·577	257 1
XI.	+ 70·872	− 22·573	107 40	+ 59·138	− 45·235	126 54	− 44·664	− 16·061	250 13
Noon	+ 63·743	− 37·106	120 12	+ 49·590	− 56·827	138 53	− 47·202	− 26·070	241 5
XIII.	+ 56·595	− 45·226	128 38	+ 38·454	− 66·296	149 53	− 44·371	− 31·451	234 40
XIV.	+ 48·186	− 50·422	136 18	+ 25·913	− 70·091	159 42	− 48·850	− 38·304	231 54
XV.	+ 41·153	− 48·073	139 26	+ 20·561	− 71·728	164 0	− 54·334	− 45·167	230 16
XVI.	+ 35·040	− 44·089	141 31	+ 4·631	− 71·798	176 19	− 57·996	− 39·127	236 0
XVII.	+ 27·425	− 31·485	138 57	− 14·115	− 64·824	192 17	− 65·628	− 27·433	247 19
XVIII.	+ 23·927	− 17·810	126 40	− 21·127	− 53·518	201 33	− 70·883	− 14·914	258 7
XIX.	+ 15·715	+ 3·696	76 46	− 32·270	− 41·336	217 59	− 74·667	+ 2·447	268 7
XX.	+ 15·921	+ 18·163	41 14	− 43·890	− 29·941	235 42	− 74·438	+ 5·879	274 31
XXI.	+ 16·499	+ 31·026	28 0	− 41·804	− 25·372	238 45	− 71·906	+ 18·603	284 30
XXII.	+ 16·339	+ 37·126	23 45	− 43·123	− 19·655	245 30	− 70·131	+ 29·678	292 56
XXIII.	+ 20·659	+ 36·940	29 13	− 43·612	− 21·447	243 49	− 66·388	+ 35·650	298 14
Midnight	+ 21·692	+ 40·064	28 26	− 47·759	− 20·941	246 19	− 66·655	+ 38·385	299 50
	+ 713·456	+ 329·615	65 12	+ 332·035	− 413·821	141 15	− 1437·909	− 204·901	261 53